Low-Cost Manufacturing by Fused Filament Fabrication of Microwave Waveguide Passive Devices for Space Applications

José R. Montejo-Garai[(1)], Carlos A. Leal-Sevillano[(1)]

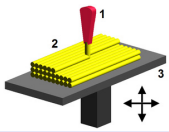
Jorge A. Ruiz-Cruz[(2)] and Jesús M. Rebollar[(1)]

[(1)] Universidad Politécnica de Madrid, Madrid, Spain, [(2)] Universidad Autónoma de Madrid, Madrid, Spain

e-mail: jr@etc.upm.es

Low-cost 3D-printing

BCN3D+



Fused Filament Fabrication (FFF)

PLA organic plastic

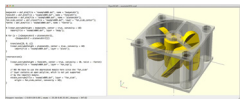
Characteristics

- FFF is a low-cost additive manufacturing process.
- RepRap project Kit BCN3D+ 740€.
- Plastic filament PLA 25€/kg.
- Use of open hardware like Arduino.
- Large makers community all over the word.
- For science and education.
- Rapid prototyping.
- Accuracy 0.1mm.

- http://reprap.org/
- http://www.reprapbcn.com/

Open Source

OpenSCAD
The Programmers Solid 3D CAD Modeller



- http://www.openscad.org/

Slic3rG-code generator for 3D printers

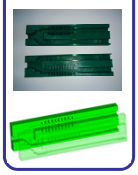
- http://www.slic3r.org/

Rapid Prototyping Science & Education

- 1 image > 1000 words.
- 1 object > 1000 images.
- Printing complex objects is cheap.
- Printing complex objects is fast.
- An object is an invaluable tool for students, scientists and engineers.
- 3D printing is an *additive manufacturing* technique, opposed to the older *subtractive manufacturing* machining systems like milling machines, CNC, etc.
- New geometries can be explored, the imagination is the only limit.

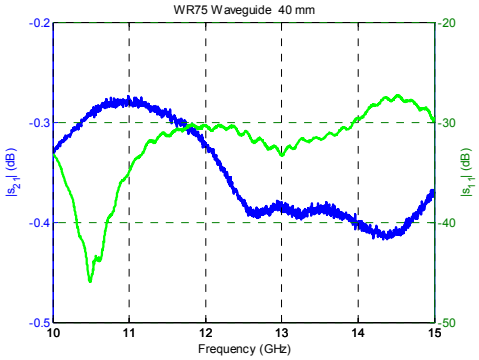
Turnstile based OMT

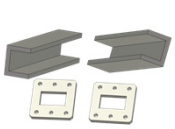
E-plane diplexer



E-plane antenna feed chain

WR75 Waveguide

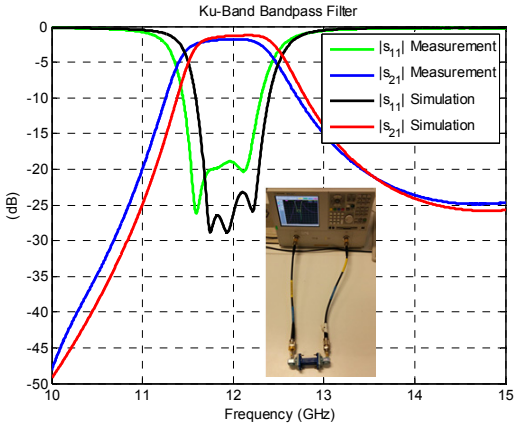




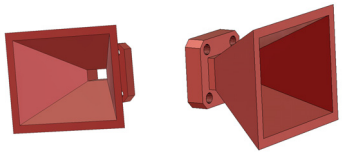
Ku-Band Bandpass Filter

Characteristics

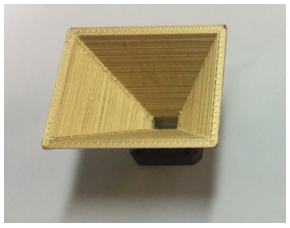
- Band-pass filter inductive irises.
- Ku band WR75: 10-15 GHz.
- Chebychev N=3.
- f_o=12 GHz
- BW= 600 MHz
- RL=20 dB
- Manufacture time: 2 hours.
- PLA cost <1€.
- Metallization by conductive coating.
- σ=50000 S/m.
- Accuracy 0.1mm.



- CAD prototype



- Printed prototype



Ka-Band Horn Antenna

Characteristics

- Pyramidal horn antenna.
- Ka band WR28: 26.5-40 GHz.
- Manufacture time: 90 minutes.
- PLA cost <1€.
- Metallization by sputtering.
- Accuracy 0.1mm.